The Toronto and Region Conservation Authority evaluates permeable interlocking concrete pavements in an effort to reduce runoff and water pollutants from development.

Cold Climate Performance of Permeable Pavers

In an effort to advance cold-climate performance information, Seneca College, King Campus near Toronto, Ontario and the Toronto and Region Conservation Authority (TRCA) are taking permeable interlocking concrete pavement (PICP) on an extended road test. Overseen by the TRCA, the four year study of parking lot runoff assesses PICP's long-term performance including the migration and treatment of runoff pollutants through the soil subgrade. Completed in late 2004, the pavement test facility includes 3,150 sf (315 m^2) of PICP with surface and subsurface water collection.

Adjacent to this area are two equally sized areas in asphalt. Runoff is collected directly from the surface of the middle asphalt area and runoff from the remaining third of asphalt drains into a bio-retention swale in an effort to assess its pollution reduction capabilities. This article focuses on performance comparisons between asphalt and PICP. Figure 1 shows the monitoring site plan and Figure 2 illustrates the asphalt areas in the foreground and PICP in the background. Asphalt curbs separate the runoff from each of the three areas. While the photo shows an empty parking lot, the entire test area is filled with cars that introduce pollutants during weekdays.

While the data gathered to date is preliminary, rainfall and runoff data from monitoring of nine storms between August and December 2005 demonstrated no surface runoff from the PICP and delayed flows from the under drains. While these results were expected from ordinary commonly occurring rainstorms, the PICP infiltrated all rainfall during large (> 25 mm) high-intensity storms. Not surprisingly, peak runoff flows from the subsurface were significantly lower and occurred later than those from the asphalt parking surface. Concerning water quality, average total suspended solids generated by the PICP were less than half of that from the asphalt. The same can be said for reduction of zinc. Bacteria, hydrocarbons, oils and grease were significantly lower coming from the PICP and bio-retention swale compared to the asphalt. All of these reinforce the benefits of improved runoff water quality by PICP before it enters lakes and streams.

Subsurface infiltration and surface runoff drain from the PICP, asphalt and bioswale into an underground utility vault with sophisticated equipment that measures flows and samples water pollutants during rainfall from each area. Water samples are analyzed for nutrients, metals, oils and conventional variables such as total suspended solids and hydrocarbons.

The PICP cross section includes 6 in. (150

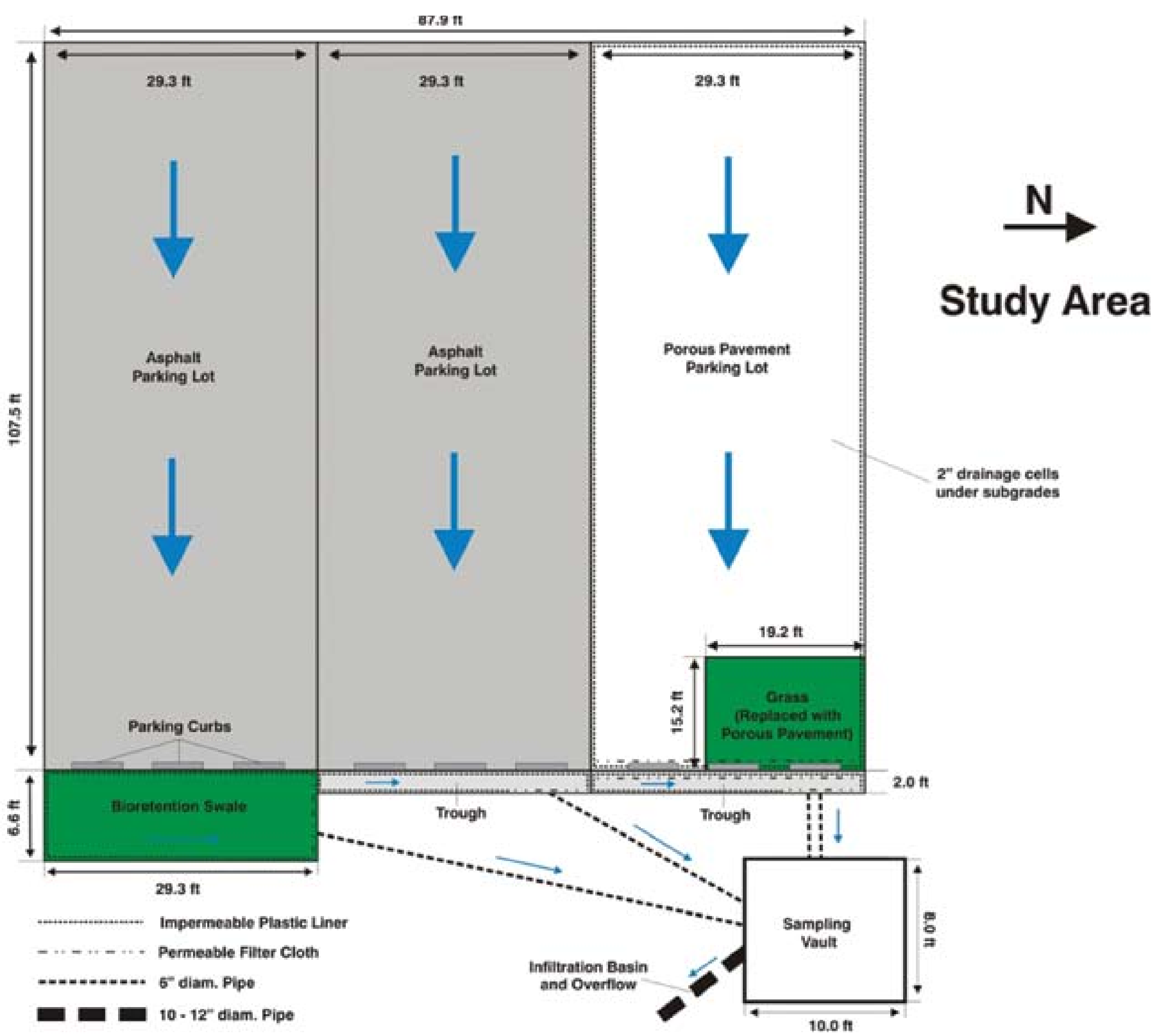

Figure 1. The Seneca College test site evaluates runoff directly from asphalt, from asphalt into a bio-swale as well as surface and subsurface runoff from permeable interlocking concrete pavement.

Figure 2. The test area is subdivided in two asphalt areas and one PICP area in the background. The asphalt curbs separate the runoff from each area.

mm) of open-graded aggregate supporting $3^1/_8$ in. (80 mm) thick permeable interlocking concrete pavers. Beneath this base is a subbase of 12 in. (300 mm) thick compacted, dense-graded aggregate, Ontario Granular A, a base material typically used under asphalt roads and parking lots. Figure 3 shows the PICP cross section. While PICP construction typically uses thicker open-graded aggregate bases without compacted, dense-graded bases under them, this experiment was designed to capture and analyze much of the runoff in the open-graded layer in order to assess its pollution reduction effectiveness.

Below the PICP base is about 3 ft (1 m) of soil encased in an impermeable liner. Water seeping through the soil is captured and piped at the bottom and directed to the utility vault along with surface runoff. Like the surface and subsurface water, flows and water quality are sampled during rainfalls from the soil layer within the vault.

Runoff from the asphalt and bio-swale is captured at the same end as the permeable pavement and channeled to the utility structure for flow and water quality sampling. A sustainable power supply for the monitoring equipment completed in summer 2005 includes a wind turbine and solar panels adjacent to the site. Rain gauges measure

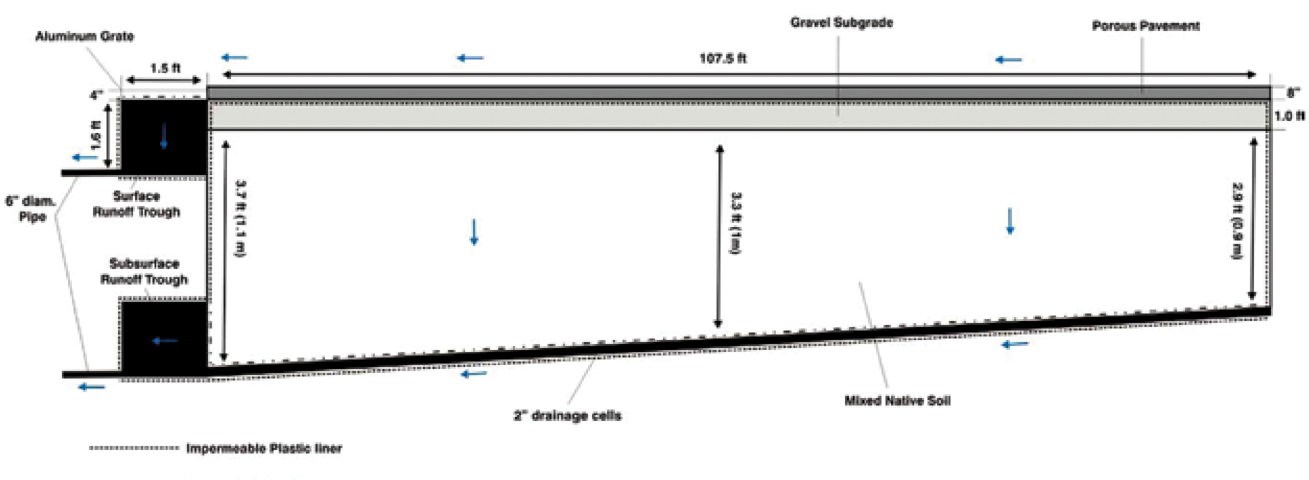

Figure 3. The PICP test area includes subsurface monitoring at the bottom of the open-graded base and further down within the soil subgrade. Water is sampled inside the troughs or utility vaults.

rainfall so there is a complete accounting of the rainfall from evaporation, runoff and infiltration. Soil samples were taken and analyzed to provide baseline chemical information to compare against any changes brought by infiltrating runoff. After samples are taken inside the utility vault, the water is directed to an infiltration trench to ensure reintroduction into the soil. The study also includes measuring the radiometric temperatures of the PICP and asphalt surfaces.

TRCA has released a 40-page, preliminary report with detailed data and construction information. A copy of the report can be found at www.icpi.org in the Design Professionals section. According to Derek Smith, Sustainable Technologies Monitoring Coordinator for TRCA, "The study will continue until September 2009. The next interim report will be released in March 2007. With more rainfall events, we expect to see trends that will more clearly indicate the effectiveness of PICP and bioswales for reducing runoff and pollutants. We'll also be exploring maintenance of the PICP surface. Our hope is to show the effectiveness of these technologies so that they become the norm for sustainable site design in the Toronto region and Ontario. If proven effective, the TRCA will work toward making permeable pavement and bioswales a key component of site design in Toronto and Ontario."

This project, organized under TRCA's Sustainable Technologies Evaluation Program, includes funding from federal, provincial and municipal government agencies, private foundations, the Cement Association of Canada and Wal-Mart Canada. The Interlocking Concrete Pavement Institute supports the project and the permeable pavers were donated by one of its members. The research is being conducted as an independent third party study. An update on the monitoring results will be provided by Derek Smith and Tim Van Seters, TRCA's Manager of Sustainable Technologies at the 8th International Conference on Concrete Block Paving, November 6-8, 2006. Future issues of this magazine will report on this important research. ❖